Controlling the motion of molecular machines at the nanoscale

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Inspired by biological systems, scientists have attempted to manipulate artificial machine-like complexes to perform work. Designing and building artificial nanoscale machines are one of the major challenges. In order to address these challenges, recent research has been focused on molecular machines as described in chapter 1. My research was aiming at the design, synthesis and development of molecular motors and their applications.

In chapter 2 the design of hybrid-motors is discussed. The goal of this research was 1) study the aggregation behavior of porphyrin hybrid-motors under controlled by the molecular motors and 2) investigate the dynamic properties of hybrid-motors based on a molecule which comprises motor and rotor functions.

In chapter 3, we described the development of an oscillating biaryl-allyl ester driven by catalysis and utilized this property to initiate movement. In order to achieve this, we designed a molecule in which oscillation can be induced by a catalytic event, via Pd-catalyzed allylic rearrangement. This catalytic process was then coupled with a dynamic function in molecular systems to induce mechanical motion.

Our aim of chapter 4 was to synthesize molecular motors capable of unidirectional rotation, in either direction, using base-catalyzed epimerization. The synthesis of a reversible motor, with the ability to rotate clockwise and counter-clockwise, depending on the initial trigger used, was achieved.

Chapters 5 and 6 described the design of the four-wheeled drive molecules, followed by synthesis and full spectroscopic characterization of their photochemistry. One of these compounds was further more used to demonstrate autonomous directed translational movement, upon fuelling on the surface, for the first time.